

BELLCOMM, INC.

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869 06019

SUBJECT: Remarks on RCS Plume Deflector Being  
Considered for LM-5 and Subs - Case 320

DATE: June 6, 1969

FROM: A. S. Haron

ABSTRACT

~~SECRET~~

The installation of four plume deflectors under the downward-facing RCS nozzles has been recommended by GAEC in response to the recent upward revision of the RCS firings duty cycle. Tenth-scale shock-tunnel tests conducted by GAEC have been correlated with full-scale vacuum chamber tests conducted at MSC. A decision to install the deflectors on LM-5 only was reached at the CCB meeting of May 28, 1969.

While the installation of the plume deflectors would permit lightening of some of the D/S heat shield assemblies, it is impractical to do that on LM-5 and LM-6 because of schedule impact. However, an earnest attempt should be made to accomplish this shield weight savings on LM-7 and subs, if the deflectors are to be installed on these vehicles.

(NASA-CR-106884) REMARKS ON RCS PLUME  
DEFLECTOR BEING CONSIDERED FOR LM-5 AND SUBS  
(Bellcomm, Inc.) 5 p

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MEMORANDUM FOR FILE

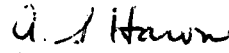
Plume impingement from the RCS nozzles facing the LM Descent Stage (D/S) imposes a severe heating load on the heat shield used for thermal protection of the contents of both the D/S and the lower portion of the Ascent Stage. This heat shield was initially designed to be compatible with a duty cycle in which the maximum firing duration was 15 seconds in any 15 minute period. MSC revised the duty cycle in November 1968 to incorporate a manual landing mode requiring 25% firing over a period of 141 seconds, later modified to 20% firing over 120 seconds.

GAEC states that the increase in RCS firing time makes it necessary to install four plume deflectors, one under each downward-firing nozzle. Each deflector (Figure 1) is about 45" long and is configured as a chute encompassing a 47° arc. It is constructed of a laminate consisting of a top layer of 1.25 mil inconel backed by 2 to 6 layers of 0.5 mil nickel, alternately separated by inconel mesh. Each chute is supported by a structural framework mounted on the D/S. The frontface of the chute is coated with black paint ( $\epsilon > 0.8$ ) and the backface is coated with white sicon ( $\epsilon = 0.23$ ). Tests conducted by GAEC indicated maximum temperatures of 1900°F (2300°F allowable) and 700°F (1000°F allowable) for the frontface and backface, respectively. Such deflectors would not only handle the additional heat flux imposed by the revised RCS-firing duty cycle but also permit some lightening of the heat shields of future LM vehicles now being fabricated.

To support the need for the deflectors, GAEC conducted a tenth-scale shock-tunnel test program in November 1968. The main test objective was to investigate the accuracy of their analysis procedure which was used to show that the heat shield installed on LM-5 would overheat under the more severe 25% RCS duty cycle. In April and May 1969, full-scale tests were conducted at MSC/Chamber A using an actual RCS engine firing in accordance with the later, less severe, pre-touchdown duty cycle. Heat flux and pressure distribution data obtained from the tests in Chamber A, and normalized with respect to data obtained from the GAEC tests, have been used to establish that the LM-5 thermal protection system is marginal. Thus a recommendation was made that the deflectors be installed on LM-5 and subsequent vehicles.

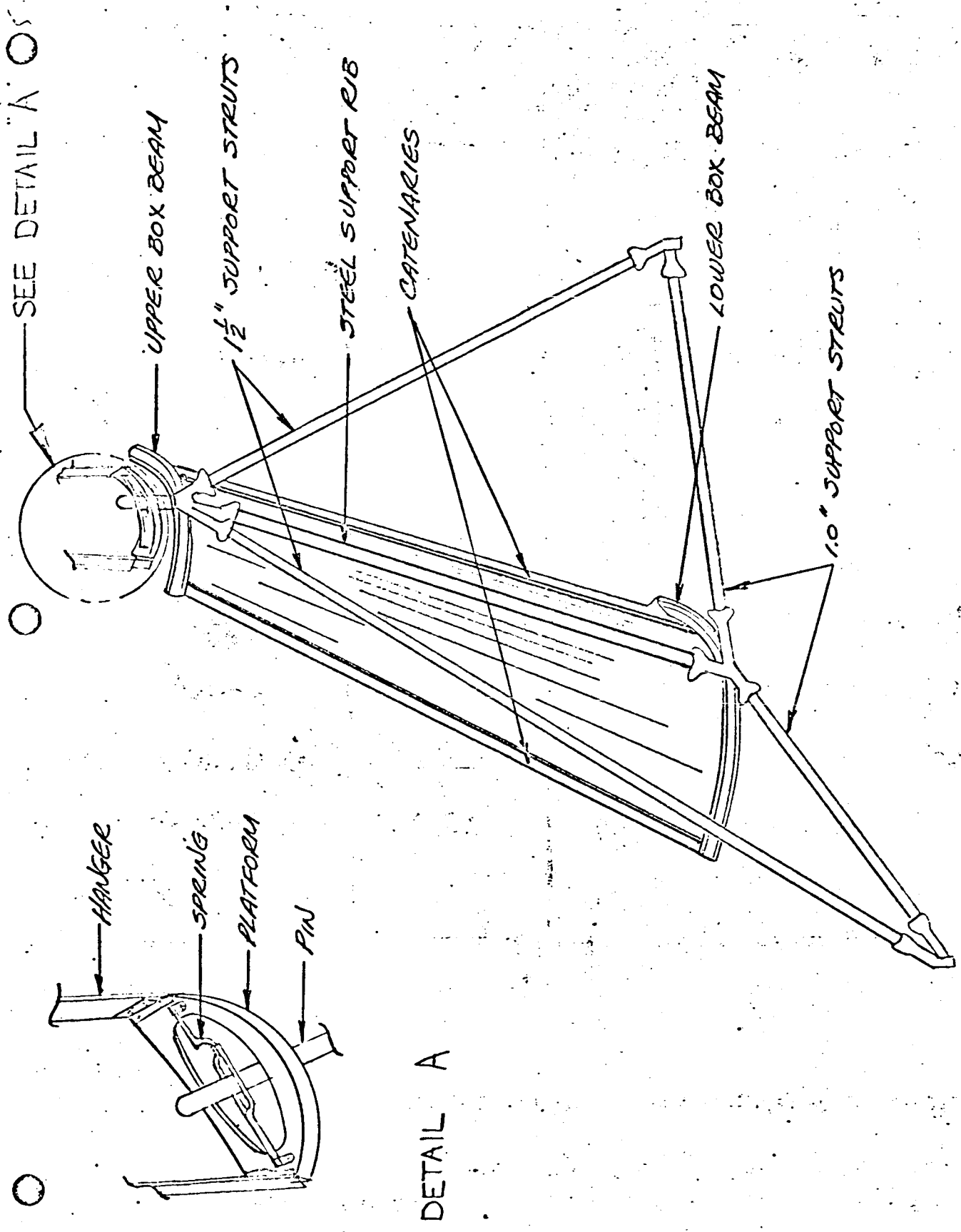
At the CCB meeting of May 28, it was decided to go ahead with the installation of the deflectors on LM-5 only, since such a decision could not be delayed. With regards to LM-6 and subs, the decision will be made later, following further study of the test results.

It should be re-emphasized that the installation of RCS-plume deflectors will permit a sizable reduction in the heat shield of future LM vehicles. While schedule impact will not allow reworking the heat shield on LM-5 and LM-6, an earnest attempt should be made to re-configure the heat shield of LM-7 and subsequent vehicles, thus realizing a worthwhile saving in over-all weight (the inert weight of all four deflectors is 32.6 lbs.).

  
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Attachment  
Figure 1



RCS PLUME DEFLECTOR

FIGURE 1

**BELLCOMM. INC.**

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